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ABSTRACT

The first in a series of monographs that describe various aspects of the development of musical intelligence, this paper describes two distinct and contrasting strategies which individuals use for making sense of simple rhythmic figures. The strategies are identified as (1) figural, related to gestures, and (2) metric, referring to measuring durations. The paper proposes that, while individuals tend to favor one of the strategies, both are necessary for intelligent musical behavior. Data are derived from children's drawings of simple rhythmic figures. Analysis shows that the dynamic interaction of the two strategies leads to development of new knowledge and to creative learning and performing in music and possible other disciplines. It is concluded that traditional schooling tends to emphasize only one strategy which does not stimulate the interaction of both strategies, thus inhibiting students' developments. Basic data and description of the taxonomies are presented in the first of the paper. Part two describes relationships between the strategies. Part three contains data that exemplify the interactions. The last section discusses the developmental issues inherent in the data and makes some suggestions for teaching music. (Author/RD)

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Memo No. 342

November, 1975
LOGO MEMO 19

THE DEVELOPMENT OF MUSICAL INTELLIGENCE I: STRATEGIES FOR REPRESENTING SIMPLE RHYTHMS

by

Jeanne Bamberger

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SP009234

This paper is the first in a series of monographs which will describe various aspects of the development of musical intelligence.

INTRODUCTION

This first paper describes two distinct and contrasting strategies which individuals use for making sense of simple rhythmic figures. The strategies are characterized by the particular features of the figures which each captures. The distinctions between the two strategies are significant to the general development of musical intelligence and may also suggest implications for learning and teaching in other domains as well. It is the thesis of the paper that while individuals tend to favor one strategy or the other, both are necessary for intelligent musical behavior. I will suggest further that it is the dynamic interaction of the two strategies which leads to the development of significant new knowledge and to creative learning and performance in the domain of music and perhaps in other disciplines, too. Finally, I will propose the theory that traditional schooling tends to emphasize one strategy over the other and in any case encourages the tendency to keep them separate rather than stimulating their interaction.

All of the data in this paper is derived from children's drawings of simple rhythmic figures. The drawings, for example, have provided the clues from which we have derived the strategies of representation. The first drawings were made spontaneously in a 4th grade music class. The second experiment involved 200 children in grades 2-6 all of whom were asked to clap and draw six separate rhythms. The third experiment included both children and adults

and involved performing (clapping) from the drawings made in the first experiment.

I have named the strategies figural and metric (or more generally, figural and formal). Figural strategy is most closely related to gesture. It involves aggregating the events of a rhythmic figure into chunks which reflect real or imagined bodily movement--what I will call the individual's "felt path"* through a series of actions. The focus of figural strategy is on the contextual functions of events; these derive from and are dependent on the fixed arrangement of durations as given in a particular figure. The focus of metric strategy is on measuring durations; measurement is derived in relation to a fixed reference--i.e., the relation of a duration to an invariant unit-time. While metric strategy thus provides a single schema for classifying events, it is not responsive to context; events which are the same in duration remain the same in spite of contextual function and regardless of the position of the event in a particular figure.

The two strategies will immediately be associated, and quite properly so, with developmental theory as formulated by Piaget and others--i.e., with pre-operational behavior in contrast to more operational behavior. However, our data shows that while figural strategy does characterize the behavior of young children (5 - 7), it is by no means limited to this age group, extending even into adult behavior. But adults who use figural strategy, unlike young

* I am grateful to Donald A. Schön for his invention of the term "felt path" and also for his many insightful suggestions which often helped to straighten the wandering "felt path" of my own thinking.

children, find metric strategy readily accessible to them once they are provided with adequate descriptive tools. As might be expected, we found that only older children (10 - 12) and adults spontaneously make use of a fully realized metric strategy. Specific musical background is also a factor: metric strategy is characteristic of those who play a musical instrument and who regularly read music from a score. In contrast, performers who "play by ear" spontaneously use a figural strategy as do individuals who do not play an instrument but said they "knew how to read music". Finally, it seems that the two strategies most often function separately even among those who have access to both.

This last finding emerged most explicitly in the third experiment where we asked individuals to play from randomly arranged figural and metric drawings. We found that participants could not play from or even accept as valid a drawing that was incongruent with their own spontaneous mode of representation. That is, when a participant's focus was on features and relations different from those encoded in a drawing, he found the representation incomprehensible, wrong or (s)he tried to fix it up to match his/her own mode of representation. The reluctance to shift strategies when there is an incongruence between encoding and decoding is an explicit instance of isolating strategies from one another.

These findings reveal behavior common to situations where, for example, an adult teacher's encoding (based on tacit assumptions)

conflicts with a child's encoding of the same phenomena. But, unlike our participants, the child, finding that the adult's description does not fit his own, may still blindly accept it in the form of a sort of ritual incantation without explicitly noting the incongruence or reconciling the two modes or representation--the different "windows to the world". As a result the child may later simply "fail to learn" or he may give the "right answer" in school and hide his wrong answer (often with a feeling of shame) saving it defensively for his own uses outside of school.

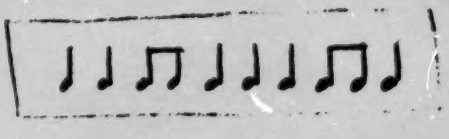
The paper is divided into four parts. Part I presents the basic data in the form of a taxonomy describing four strategies of representation derived from the children's drawings. Part II describes relations among the four strategies which suggest that they can be compressed into but two. These two basic modes of representation are then shown to have significant implications in the broader world of musical understanding and performance. Part III.1 presents another set of drawings which show a mix of strategies. These hybrid examples illustrate possible interactions between strategies and point the way towards interventions in a teaching-learning situation. Part III.2 describes the encoding-decoding experiment and provides more data to reinforce the importance of the dynamic interaction between the two strategies.

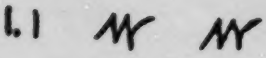
Part IV discusses the developmental issues inherent in all the data and makes some explicit suggestions for teaching. Part I is essential for all the parts which follow. Part III.1 tends to be rather technical and may be rather hard going for those with little music background. Part IV will be of particular interest to educators.

Part I

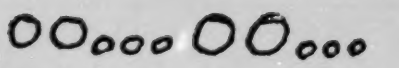
Consider the following drawings each of which represents the same rhythmic figure. The figure was invented by children in a number of different music classes (grades 3 through 6) in the course of group improvisations. The first set of drawings was made spontaneously when the children wanted to keep a record of what they had done. It was suggested that they,"Draw a picture of your claps so you can remember them next week or so someone else could play them." The children were encouraged to draw anything they liked. The following drawings are much less colorful copies of a few of these pictures:

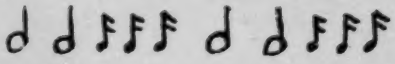
I

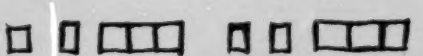


1.1 

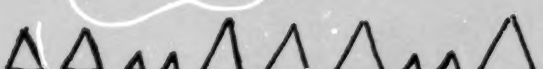
II

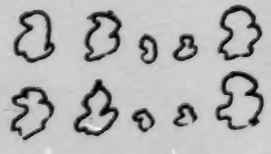
2.1 

2.2 

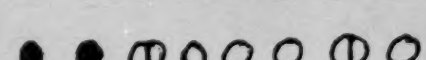
2.3 

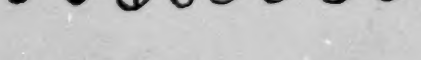
III

3.1 

3.2 

IV

4.1 

4.2 

The drawings fall into four categories:

Type I -- Pre-representational

Type II -- Motivic-Gestural

Type III -- Durational

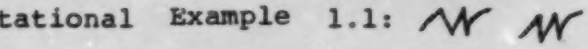
Type IV -- Systematically measuring or metrical

The types of drawings have been grouped according to the strategy of representation each reflects. The ordering of strategies derives from their degree of analysis and abstraction from direct sensory-motor mapping--i.e., the knowledge involved in hearing the figure and directly playing it back. In order to play the rhythm correctly, the child must "know" it--he must already have some internal mode of representing it to himself simply in his capacity to remember it and reproduce it. The question becomes, then, what are the various ways that children "grab" this sensory-motor knowing when asked to project it in a drawing--in this sense, to describe their way of knowing or thinking the figure. What features of the figure, what relations will be captured in their drawings, what will be ignored?

The mode of representation in Type I drawings, for example, derives directly from sensory-motor mapping. Type II strategy is influenced by sensory-motor factors but the children capture these factors in a description which explicitly groups contiguous events into chunks or motives. Type III strategy involves reflection on these actions to capture the property, relative duration of events, and makes use of the notion of

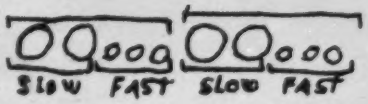
class membership. Type IV strategy includes a still more exact description of duration--a systematic way of measuring events in time.

The distinguishing characteristic of the drawings lies in which claps are drawn the same--same size, same shape, etc. In the discussion which follows I will ask, then, in just what sense are these claps alike, in what sense do they belong together, are they, then, members of a single group?

Type I: Pre-representational Example 1.1: 

Type I drawings are different from all the others, first of all, in their mode of production. These children unlike the others, actually played the rhythm on the paper with their crayons. That is, their crayons moved across the paper first slowly (^), then proportionally faster (^); a pause, crayon suspended in air, then a repetition of the previous motions. The child's performance of the figure thus leaves a trace for each event but no trace of the changes of pace which he actually played. The result is a drawing which captures the total number of events of the figure along with the articulation of the whole figure into its two repeated segments. The repeated squiggles describe the child's path through each segment but shows no distinctions or relations among his individual movements other than succession (next-next-next). So the child's varied actions generate the

picture but the drawing, itself, does not describe what he actually did.[1] His own "knowing"--his capacity to remember and reproduce the figure--remains in its sensorimotor mode. It is for this reason that Type I drawings are called pre-representational.

Type II: Motivic-Gestural Grouping Example 2.1 

Type II drawings are like Type I drawings in that they capture the number of events and the articulation of the whole figure into its two repeated segments. However, Type II drawings differ from Type I drawings in three ways:

1) The children obviously did not play-draw the figure on the paper. The representation of the "felt path" is distanced from direct sensorimotor behavior; the drawing is the result of thought actions rather than simply a copy of the actions put on paper.

2) The drawings capture a further articulation of the two repeated segments. Each larger group is divided into two inner groups or motives. In this sense, the drawings are hierarchical.

3) Type II drawings capture the feature, change of pace, but they do so in a functional way. That is, the feature, change of pace, is only captured when it serves to set off a gestural group; the

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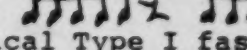
[1] This is made quite explicit by comparison with another figure:  When performed on the paper in the typical Type I fashion, the trace left is the same as Ex. 1.1: The two figures share the same number of events and the feature, repetition. Since neither drawing shows distinctions among movements within the larger figures, the traces left are identical.

durations[2] of events are not consistently compared one to another. Thus, the child's thought actions result in a more complete description of the figure than directly drawn actions; reconstruction of the felt path includes more landmarks--larger and smaller goals. But still, the child's focus is on the sense of his actions as these cluster into groups as he moves through the figure. When asked about Example 2.1, this child said, "The three little circles go together and they get faster." He indicated that "go together" meant bound together as in one gesture--i.e., the clustering of his actions in relation to a goal or node towards which they move.

However, not all the events in this second gestural group "get faster". The beginning of the group is, indeed, set off by a change of pace--claps 3 and 4 get faster--but the group is bounded by or stopped by another change of pace--clap 5 is again an event of longer duration. But this child draws clap 5 the same as claps 3 and 4, not the same as claps 1 and 2 which, in fact, share the same duration as clap 5. It is the <u>function</u> of the longer duration within this particular context which gives it group membership--boundary event of the gestural group, the node around which the previous two claps cluster--and it is this contextual function which makes it <u>the same</u> as those events which "go" with it or perhaps "to" it. The <u>means</u> which generate this function--longer relative duration--is ignored as irrelevant by Type II

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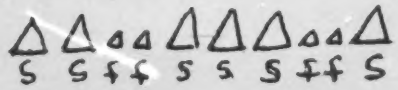
[2] By duration I refer to the time from one attack to the next. The word might also refer to the time that the sound lasts. However, in the case of claps, the sound is always brief in extension and also always the same in this dimension. If the figure were performed on a single pitch and sustained (sung), this dimension might play a different role.

drawers. That is, contrast in the rate of events is only a salient feature when it functions to set off a gestural group, the goal of the group is simply its end, it is not measured.

This points to a crucial aspect of Type II strategy: Durations are not compared across motivic groups--i.e., clap 5 is not compared to claps 1 and 2, nor to clap 6. Claps 1 and 2 are contained within a separate, distant group and the time between the larger segments (between claps 5 and 6) is, so to speak, null. One child said of it, "It doesn't matter how long that one is, you just stop and start again."

So, while Type II drawings are the result of thought actions rather than immediately performed actions, the focus is still on the articulation and clustering of actions which are contiguous--the grouping of events along the child's felt path as he moves through the figure. Durational means are salient only in their contextual <u>effect</u>; the <u>result</u> of their particular position in the chain of events. The strategy does not include comparing the duration of events one to another when the events are contained within separate motivic groups.

Type III: Durational Grouping Example 3.1 

Type III drawings differ from Type II drawings only in their picturing of claps 5 and 10. However, the difference is significant. Rather than grouping together events which go together in action, Type III drawings represent as the same, all members

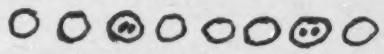
of the figure which share the feature, same relative duration. A group is defined, then, as the class of all events with the same relative duration. Thus, there are two kinds or classes of events in the figure: Longer events which are consistently given larger shapes, shorter events which are consistently given smaller shapes.

Of particular importance is that Type III strategy includes comparison of the durations of events across motivic groups. For example, claps 2 and 5 are drawn the same even though they belong to separate inner gestures; claps 5 and 6 are drawn the same even though clap 5 is the boundary event of one large segment and clap 6 is the beginning of the other larger segment. The time from clap 5 to clap 6 is not null; time continues on across the border and is measured in relation to the events around it. Thus, it is not contextual function which is the central focus in Type III strategy, the focus is rather on the means which generate these functions. But as a result of this focus on means, Type III drawings obscure motivic grouping structure. The articulation between the two large segments is hidden and the grouping together of claps 3, 4 and 5 is interupted. Thus, in capturing durational grouping structure, Type II drawings ignore the gestural grouping captured by Type II drawings.

Type II strategy, then, assigns group membership as a result of the way movements "go together". It is responsive to the contextual function of an event along the performer's felt path--i.e., to the position of an event in a particular sequence of contiguous

actions. Type III strategy assigns group membership as the result of the relative duration of events compared one to another. Two events will thus be members of the same Type III group regardless of context, regardless of where the event occurs in a particular sequence or its function in that sequence. Type II strategy says clap 5 is different from claps 1, 2 or 6 because it has a different function; Type III strategy says clap 5 is the same as claps 1, 2 and 6 because it has the same relative duration.

Type IV: Systematically Measuring or Metric Example 4.1



Type IV strategy goes one step further than Type III strategy. Still focusing on the property, duration, events are measured, now, not only one to another but in relation to an invariant unit-time, the beat. Type IV drawings capture the exact duration of the foreground events, the claps, by placing them on an invariant background grid. The background beat is always drawn as, , while foreground divisions of the beat are shown against it, . Thus, the continuing iteration of the beat can always be seen and the relation of foreground events to it is made graphically explicit.

When the performed event is equal in duration to the underlying beat, (that is, when foreground and background coincide) only the beat is shown. When the performed events are some division of the underlying beat, the beat is shown as background and the division is shown by the appropriate number of dots inside the circle. Thus, the first two events establish the rate of the constant time unit. The beat continues on but claps 3 and 4 go twice as fast dividing the unit time into two. The 5th clap again coincides with the beat. Only these drawings, then, capture a two-dimensional time structure--the relation of the varied durations of the foreground to the invariant beat of the background. We see 8 beats and 10 performed events.

With this strategy the children abstract a feature, the 8 beats, which is only implicit in their direct, sensorimotor experience--i.e., they represent a feature of the figure that was actually not heard or played, not a part of their felt path, but which was, nonetheless, generated by the figure. In abstracting this invariant unit time, the children have also built a general system with which they can accurately measure and reconstruct any events in time. But once again it must be emphasized that the motivic grouping of Type II strategy is not displayed. Events are classified as the same or different in relation only to their exact, measured duration; their contextual function is ignored. Thus, for example, an event which functions as the boundary or goal event of a motive (clap 5) is represented as the same as an event which functions as the beginning of a motive (clap 6)

because each happens to equal the unit time.

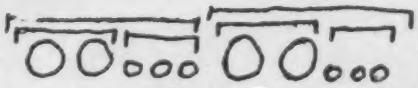
Comparing all four strategies, now, we see interesting contrasts in kinds and numbers of elements, kinds and numbers of groups and a significant difference in capturing relations of slow and fast:

I

1.1

5 + 5

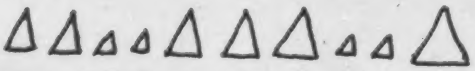
II

2.1 

[2 + 3] + [2 + 3]

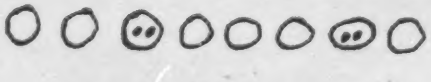
S F S F

III

3.1 

S S F F S S S F F S

6 slow elements; 4 fast elements

4.1 

8 beats; 10 events

Part II

So far I have been concerned with a description of the characteristics of the drawings and with grouping them according to the particular features which each captures--the taxonomy. In doing so, I have used the term, representation, to mean simply what is represented on the paper and the term, strategy of representation to mean an individual's processes of reconstructing the figure. What the child draws, then, provides the clues to his strategy of representation.

In developing the taxonomy I have tried to emphasize the special characteristics of each type. While I have noted varying degrees of distancing from sensory-motor mapping, I have tried not to suggest that one type is better than another or that the four types illustrate a normative progression towards a single goal. However, there is another kind of progression that does emerge: from Type I to Type II there is a movement towards greater inclusion. That is, in both Types I and II the focus is on action, gesture; in terms of this shared feature focus, Type II includes more but not different features. Specifically, Type I drawings articulate the larger gestures, and capture the features, number of events and repetition; Type II drawings include these features and also further articulate and group previously undifferentiated events in response to change in pace. Thus, a Type II drawing is a more complete graphic description than a Type I drawing. And in terms of the task, itself ("Draw a picture of

your claps so you can remember them..."), Type II drawings are more adequate because they include more information for later retrieval (see the note on Page 4).

The same kind of relationship exists between Types III and IV. Here the focus is consistently on the relative duration of events but Type III strategy compares events only one to another while Type IV strategy measures the exact duration of each event in relation to an invariant grid. Thus, Type III strategy labels two kinds of durations--longer and shorter--but Type IV strategy describes how much longer and how much shorter. So in terms of their shared feature focus, the movement from Type III to Type IV is again one of greater inclusion: Type IV drawings include more but not different information.

Of course, the line between more and different is always a fuzzy one, sometimes even arbitrary. At what point does more become different? While it may be a matter of degree, the distinction between more and different, here, is striking if we compare the relation between the adjacent pairs, I-II and III-IV, with the relation between the remaining adjacent pair, II-III. Type II drawings capture features not found at all in Type III drawings. In turn, Type III drawings capture features not found at all in Type II drawings. Specifically, Type II strategy captures the grouping of contiguous actions into motivic chunks and reflects the function of events in the context of these chunks. But in doing so, Type II strategy ignores the feature, same

relative duration when this occurs across chunks. Type III strategy captures the feature, same-different relative duration, but ignores, even obscures, the grouping of events into motivic chunks as well as the contextual function of events within these chunks.

This difference in features captured suggests that the relationship between II and III is one of disjunction rather than one of progression. In the light of this disjunction, together with the similarities observed in the other two adjacent pairs, I will compress the four types, now, into but two: I-II I will call figural representation, III-IV I will call metric representation. Having done so, I would like further to suggest that the distinction between figural and metric representations found in these rudimentary examples is relevant also in the broader context of the performance and understanding of actual musical compositions. Indeed, it is because of these wider connotations, that the children's drawings gain particular significance.

In the more traditional language of performing musicians, figural representation has to do with "phrasing", with the "shaping of a phrase". The performer reflects and projects figural grouping in his decisions concerning bowing, breathing, fingering, dynamic stress and the subtle give-and-take of the measured beat. The figural grouping he chooses derives from the particular collection and sequence of proximities as they occur in the flow of the piece. Within any one piece figural grouping and the figural function of an event may change,

transform, regroup in response to particular proximities, particular contrasts. In turn, any two events that are equal in duration can take on quite different functions in the figural context of a given passage.

Metric groups correspond to the beats and measures indicated in standard music notation--meter in the larger sense of measurement of durations in relation to some unit-time (beat) and the aggregation of this unit-time into larger or slower units (measures). In contrast to figural grouping, metric grouping remains largely invariant throughout a piece, at least in the music with which we are most familiar and most imbued. Thus, the metric function of an event will always be the same or different from another event in relation to its place on the temporal grid not in relation to its particular context. In this sense, meter provides a single scheme for defining the function of any event in a given piece regardless of its position or contextual function in a particular figure and regardless of its particular proximities with other events.

The distinction is, I think, similar to the one made by Cooper and Meyer in their book, The Rhythmic Structure of Music. They use the terms, rhythmic grouping and meter. Their use of the term, meter, is much the same as mine: "Meter is the measurement of the number of pulses between more or less regularly recurring accents. When pulses are thus counted within a metric context, they are referred to as beats."[3] Meter, then, reflects

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[3]Cooper, G. W. and Meyer, L. B., The Rhythmic Structure of Music, University of Chicago Press, 1960, p.4.

the regular marking off of time into beats and groups of beats; it is that dimension of temporal structure which makes counting and measuring possible.

Rhythmic grouping is more difficult to define, briefly. However, crucial to their notion of rhythmic grouping is the role of what they term, accent--a node or nucleus around which events in a group cluster. "An accent is a stimulus which is marked for consciousness in some way. It is set off from other stimuli because of differences in duration, intensity, pitch, timbre, etc... The accented (event) is the focal point, the nucleus of the rhythm around which the unaccented (events) are grouped and in relation to which they are heard...Grouping is a product of similarity and difference, proximity and separation of the sounds perceived by the senses and organized by the mind."[4]

Rhythmic grouping, then, is generated in actual compositions by many factors (pitch, dynamic stress, harmony, instrumentation, etc.). In our limited example which included only "claps" of varied duration and all of the same loudness, grouping must be generated simply by a change in pace, a contrast in the duration of surface events. In the discussion of Example 2.1, above, I pointed out that the grouping of claps 3, 4,and 5 was "set off by a change of pace" and"bounded at the end by another change of pace--an event of longer duration." In this example, clap 5, the "boundary event",is the "focal point, the nucleus of the rhythm" around which the previous two claps cluster. Of course, the focal point may occur in any position in a group. Indeed, the place of the nucleus

[4]Ibid., p. 8-9.

is influenced by many factors in actual music--the larger structure in which any small figure may be embedded, the interaction of parameters including the underlying metric grouping, etc. So, having made the distinction between rhythmic grouping and meter at the outset, the authors take pains to demonstrate that it is often a dynamic interaction between rhythmic grouping and meter that defines, even generates the particular rhythmic structure of a given passage. Finally, Cooper and Meyer emphasize the importance of rhythmic grouping in the performance of music:

> There are no hard and fast rules for calculating what in any particular instance the grouping is. Sensitive, well-trained musicians may differ. Indeed, it is this that makes performance an art--that makes phrasings and different interpretations of a piece of music possible. Furthermore, grouping may at times be purposefully ambiguous and must be thus understood rather than forced into a clear decisive pattern. In brief, the interpretation of music--and this is what analysis should be--is an art requiring experience, understanding and sensitivity.[5]

Now, the intriguing thing about the examples of children's drawings thus far is that these two aspects of rhythmic structure emerge in such a clear and distinct way and yet they are always separate--the drawings capture either figural or metric features. The simplicity of the figure, itself, is undoubtedly one factor--its brevity, its restriction to but claps and varied durations, its unambiguous metric and figural grouping structure. Further, it is not surprising that a child chooses to, or even is only able to, deal with one aspect at a time. But the question arises,

[5]Ibid., p. 9.

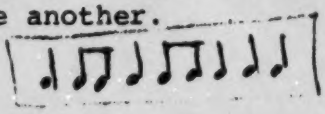
how does this dynamic interaction, so crucial to musical performance, develop? Under what circumstances can we find it, what explicit forms will it take, and what effects will it have on learning and understanding more complex music? In the next section I will present two sets of data which hopefully will serve as a beginning step towards confronting these issues.

Part III.1

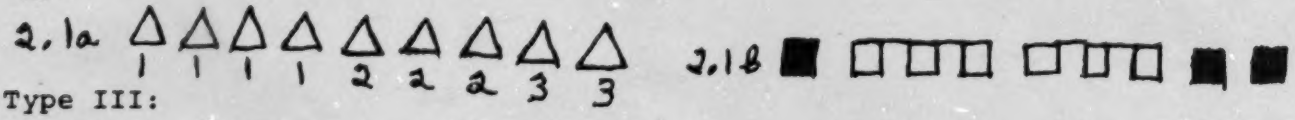
Stepping back again to the mini-world of simple rhythms and children's drawings, consider the next examples which were made by children in grades 3-6. The particular figure I will discuss was one of six that the children were asked to clap and draw. The children first listened to each figure played on a drum, then clapped it back, repeating until the observer was satisfied that all the children could play it correctly. The next instruction was the same as in the previous experiment: "Draw a picture of your claps so you can remember them next week or so someone else could play them." In addition, the children, this time, were asked to "put in numbers that seem to fit." But this instruction was given only <u>after</u> they had completed their drawings and was coupled with a repeat performance of each of the figures. Putting in the numbers, then, was a second pass at reconstructing the figure, this time using another mode of description. This was important for two reasons: 1) It gave us a chance to see if a given child's strategy was simply one possibility with another just as available. 2) It also shed some light on how the change in medium of description might influence the particular feature focus.

The second pass factor together with certain characteristics of the figure, itself, produced interesting results: many of the drawings are "hybrids" in relation to the previous taxonomy. That is, many of them include a mix of strategies and thus do not fit neatly into one type or another. As a consequence, they provide useful data for pursuing the question of just how figural and metric strategies can interact or influence one another.

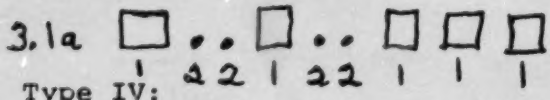
First, some pure examples:



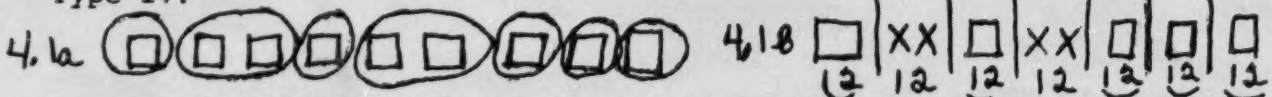
Type II:



Type III:



Type IV:



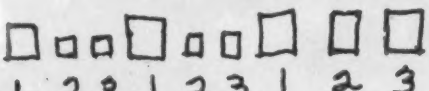
In Example 2.1a all events are drawn with the same size and shape. So, the drawing, itself, is like a Type I drawing--a series of undifferentiated claps--but, still, not performed on the paper like a typical Type I drawing. The numbering clearly shows motivic grouping. There are three groups: Group 1 (1111), Group 2 (222), Group 3 (33). Thus all the members of a single gesture are assigned the same number and there is a serial progression from one group to the next. Contrast in pace is entirely embedded in the figural response like Example 2.3 of the earlier set. Example 2.1b is included because it suggests a different way of chunking the figure--i.e., a different

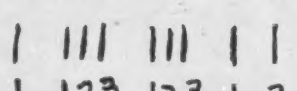
"interpretation". Claps 2-3-4 and 5-6-7 are clearly bound together--they "go together" in a single gesture. The graphics are similar to Example 2.3 in the earlier set, indeed, the figure is the same: The darkened squares, are all events of longer duration, but they also seem to suggest two groups of a different kind: the first clap is a free-standing group with one member, only; the second group has two members both with the same duration. Thus, the means which generate grouping, especially in this last instance, are different from the means which generate the bound together groups. I will return to this example later on.

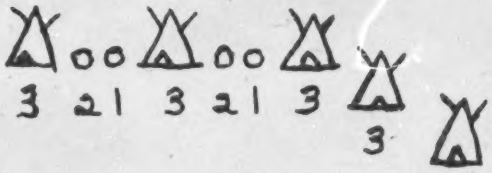
Example 3.1a is unambiguously durational. Longer durations are given bigger square shapes, all shorter durations, smaller dots. The numbering names the two kinds of durations--longer durations are named "1", shorter durations are named "2".

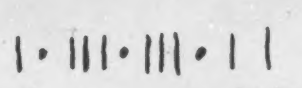
In Example 4.1a the unit time is drawn as a circle, the performed events as squares. So when there are two performed events for one unit beat, the performed events are contained within the circle. Example 4.2a is included because it captures not only the two kinds of events □ and XX and the two-dimensional structure of 4.1a--beat as related to performed events--but also the proportional relations between two constant time units--the faster pulse (1 2) and the slower pulse (| |).

Now to the hybrid examples:

H.1 
1 2 3 1 2 3 1 2 3

H.3 
1 123 123 1 2

H.2 
3 21 3 21 3 3 3

H.4 
5 005 005 55

First some general comments, after which I will deal with each example in more detail. Each of the hybrid examples presents a different mix between figural and measuring strategies.[6] H.1 and H.2 are similar in capturing metric features in the drawing and figural features in the numbering. H.3 and H.4 are particularly interesting in that the drawing, itself, captures both figural and measuring features. But when adding numbers, the H.4 drawer used a figural strategy while the drawer of H.5 preferred to focus on relative duration.

Most interesting is that even when the strategy is figural, the particular chunking can differ. H.3 and H.4 suggest the same chunking as 2.1b, while H.1 and H.2 suggest another way of chunking the figure. Thus, these are two different "interpretations" or two different "phrasings". The question then arises just what features of the figure influence the performer-listener's "interpretation"? The question is significant because it is this sort of difference in feature focus which often determines differing interpretations in the performance of actual musical compositions.

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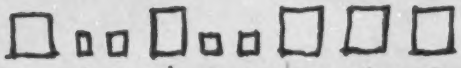
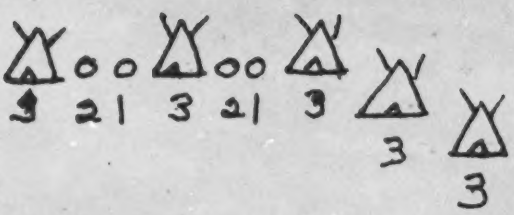
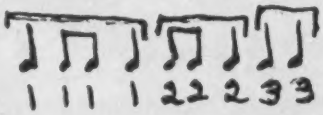
[6] All the hybrid examples combine Type II and Type III strategies in various ways. We found no instances of Types I or IV combined with other strategies.

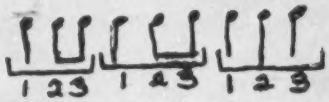
H.1 

H.2 

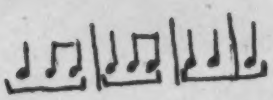
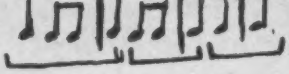
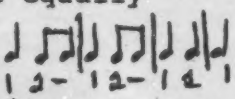
The drawing, alone, in H.1 unambiguously captures the two kinds of durations--a pure Type III strategy. The second pass numbering shifts to a figural representation; it assigns a series of consecutive numbers to contiguous events rather than naming like events with like numbers. Thus, Example H.1 mixes Type III strategy and Type II strategy.

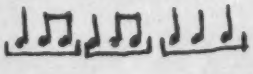
But significantly the motivic grouping suggested by the series of numbers is different from that found in the purely motivic strategy of Example 2.1a:

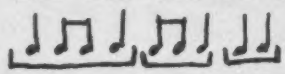
2.1a 

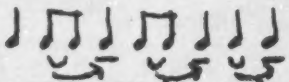
H.1 

Specifically, the groups in H.1 <u>begin</u> with the longer duration, the shorter durations follow after; the groups in 2.1a <u>end</u> with events of longer duration, the shorter durations going to them (♩♫ vs ♫♩). It is a difference in interpretation or phrasing which Cooper and Meyer describe as beginning-accented in contrast to end-accented. The difference in interpretation in H.1 is probably influenced by the initial metric focus. With the initial focus on relative durations, the figural groups tend generally to coincide with, to be contained within the larger metric units, thus:

 rather than crossing over them as in 2.1a: 
Thus, the motivic groups captured by the second pass numbers are essentially metric groups. However, a consistently metric numbering (see Cooper and Meyer's definition of meter) would count <u>on</u> the unit-time, not on the surface events. It would thus assign numbers only to each of the 7 unit beats and in addition would show the equally invariant grouping of these units into twos (not threes): 
But when putting in the numbers in Example H.1, the child is influenced by his actions. That is, he counts <u>on the performed actions</u> rather than counting off or ticking off the invariant unit beats which need to be extracted as another dimension of the structure. Still, while his focus shifts from measuring to felt path, the initial focus on measuring shows through--the counting up of performed actions coincides with the larger (or slower) metric unit. Thus, the figural grouping is, itself, influenced by both action and measuring.

So the purely figural focus represented in 2.1a is in response to the child's immediate sense of clustered actions, of moving <u>towards</u> the accent or goal. In H.1 the child's initial focus on the regularly recurring accents which mark off time results in motivic groups that <u>take off</u> from these accents rather than moving towards them. And appropriately, the result is a set of relatively <u>symmetrical</u> chunks:  The first two groups are identical and each group has the same number of events. Only the final group crosses over the metric unit to make an end-accented

final cadence but still comes out even in neat 3's. The symmetry of these figural groups is in contrast to the assymetric groups of 2.1a. There, the number of events and the set of specific durations is different in each group:  And yet, the strategy for what generates a figural group is equally consistent--specifically, events cluster together in relation to the node towards which they move: clap 1 belongs to those that follow it simply in order not to stand alone. The figure, is a compelling gesture because of the relatively longer duration at the end and because of the faster claps which gravitate towards it. The repetition of this gestural group establishes a normative grouping structure characterized by a total duration of two beats and end-accented. The last two events become a group, then, as a variation on this norm--it also includes 2 beats and is end-accented.



Example 2.1b can now be understood as a refinement of 2.1a. The first clap is left to stand alone, the subsequent change of pace separating clap 1 from those that follow. The varied final group is distinguished from those that precede it because its surface events all have the same duration--it is a group as a result of the preceding context.

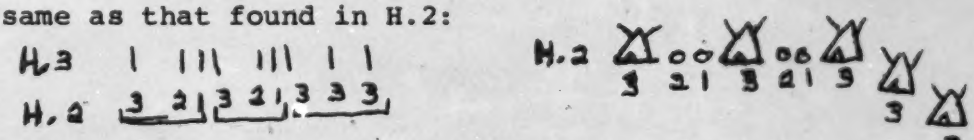
Example H.2 is included because, while it is similar to H.1, this child relinguished her motivic strategy at the end in favor of a consistently durational focus--i.e., the longer durations are consistently named, 3. Incidentally, the reverse numbering in this example (3 2 1 rather than 1 2 3) seems to emphasize the

importance of the accent generated by the longer durations--the larger number somehow implies more weight. In these terms, the performance of H.2 would suggest a fine crashing cadence at the end. This interpretation of the figure is graphically and charmingly reinforced by the descending line of tepees on the final three claps--or are they Indian drums playing?

H.3: | ||| ||| || H.4: |·|||·|||·||
1 123 123 12 5005 00555

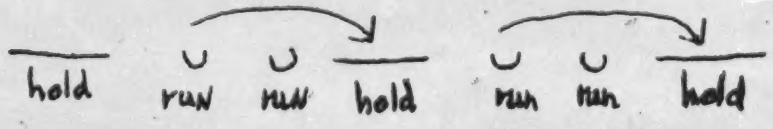
H.3 and H.4 are perhaps the most interesting examples and, indeed, have the greatest implications for teaching and learning. We found many examples of this kind of notation. A crucial aspect of these drawings is that they, like Type I drawings, were actually played on the paper. As if simulating the time continuum, the children moved their hands continuously across the paper marking off this time continuum with their claps-lines. The result is a literal spatial analogue of the temporal relations of the figure. And the trace left captures both motivic and durational features. The spaces between lines show relative durations and the lines themselves show the events and a visable clustering of these events. But it is the spaces which create this visable clustering. That is, a relatively larger space on each side of a set of contiguous events forms the contiguous events into a self-standing group; a single event separated from those contiguous to it by a larger space stands relatively alone. The visable grouping which results is the same as the motivic grouping expressed by Example 2.1b.

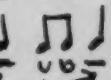
Substituting, now, longer duration for larger space, we can translate the visual-spatial grouping into durational terms: A relatively longer duration on each side of a set of contiguous events forms a self-standing group of the contiguous events; a single event of longer duration stands relatively alone. The first part of this statement is simply another description of the grouping process which was described earlier in terms of actions: A motivic group is "set off by a change of pace and bounded at the other end by another change of pace." Thus, the time-space analogue created by actual movements shows in an immediately visable way the motivic groups captured by a figural strategy and also the durational means captured by a metric strategy. We have, then, another example of the relation between durational and motivic features--in this case, one of cause and effect. But notice that the motivic grouping of these last drawings is not the same as that found in H.2:



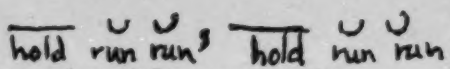
Indeed, the grouping of H.2 patently conflicts with the visual clustering of H.3 and H.4. The difference in the strategies from which each of the drawings derives should make clear the powerful effect of the priorities given to particular features:

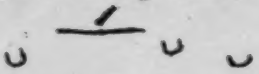
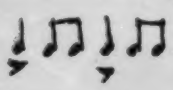
Remember that the drawer of H.3 began with movements across the page. Her actions can be compared to the steps of a dancer moving across the stage. The dancer's path is punctuated by the landmarks formed when faster (running) steps arrive at a "hold":



Like the child clapping, the dancer's actions go naturally towards the "hold", the accent. It is in this sense, too, that the felt path of the clapped figure tends to go to the longer durations--i.e., the groups are end-accented: 

But, recall, now, that the drawer of Example H.2 did not begin by actually performing her actions across the page; instead she reflected on these actions to capture longer and shorter durations. Then, looking back at her picture with its focus on durations she counted down from the first longer duration to the next and started over again. In this way each longer duration marks the beginning of a new group; groups thus become beginning-accented. The priority given to metric features leads to a different interpretation.

But how could the performer or the dancer project this contrasting grouping in action? Try to imagine walking the rhythm so that the running steps come at the end of a group--i.e., with the faster steps separated from the hold: 

It's hard to do; the running steps seem irresistably to spill over to the hold. One way to keep the running steps from spilling over is to explicitly mark each beginning with a stress, perhaps a stamp. This way the running steps will seem to go down (in sound) from the first stamp and to begin again with the next stamp:  In clapping the figure the same effect can be created by simply playing the longer duration louder: 

From this it should be clear that given only durational contrast, a relatively longer duration will naturally create an accent and, in action mode, the felt path will naturally lead to this accent to create end-accented groups. To transform these naturally end-accented groups given by durational contrast, alone, such that the longer duration becomes the front of a motivic group, the accent must be reinforced by stress. Thus, to project a grouping derived from durational focus (e.g., Example H.2) it is necessary to add the feature, loudness, to the given contrasts in duration. And now the numbering 3 2 1 found in Example H.2 can be understood as directions for performance, too. Cooper and Meyer put it this way:

> In this admittedly difficult problem of grouping there is, however, one fundamental set of rules for the organization of relationships within groups: durational differences, which necessarily result in the temporal proximity of some stimuli and therefore in the separation of others, tend to produce end-accented groupings; intensity differentiation tends to produce beginning accented groupings... Thus, as we shall see, a normally end-accented temporal organization may be made beginning-accented by placing a stress on the accent...

We can now go one step further and say that the choice of interpretations between beginning-accented and end-accented groups is influenced by the performer's initial representational strategy--by his/her inital feature focus. That is, a particular interpretation will be influenced by a focus on the natural punctuation resulting from the felt path of durational differences or, on the other hand, a more reflective strategy with its focus on

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[7] Cooper, G. and Meyer, L., op. cit., p. 10.

measuring and counting of recurring units. The former will result in end-accented grouping, the latter in beginning accented grouping and will require the addition of stress if it is to be projected in performance. This, then, is an explicit example of how priorities given to particular features can influence a performer's interpretation (literally reconstruction) of a given figure. And if the performer can freely move between figural and metric strategies, (s)he is in a position to choose the more appropriate interpretation depending, for example, on the larger context in which a figure is embedded or even on the particular character (s)he wishes to project.

Finally it is not surprising to find both motivic and durational numbering in conjunction with these last drawings since the drawings, themselves, capture both kinds of features. In H.3 we see a purely motivic numbering in the second pass. (In contrast to 2.1a, the numbers progress serially within each group rather than from one group to the next.) In H.4 we see durational numbering--all longer durations are called "5" and all shorter durations are capriciously called "0". Thus, the spatial analogue can lead its performer-drawers either way. For this reason it becomes a very powerful vehicle for encouraging the crucial interactions between figural and metric strategies.

Part III.2

In another rather informal experiment we showed 10 adults and 8 children the examples on Page 1 randomly arranged, and asked them simply to clap the figure. The players were told beforehand that all the drawings represented the same rhythm. Each of the ten participants performed the rhythm correctly almost at once. When asked, "How did you do that?", each player identified either a Type II or a Type III drawing as the basis of his/her performance.

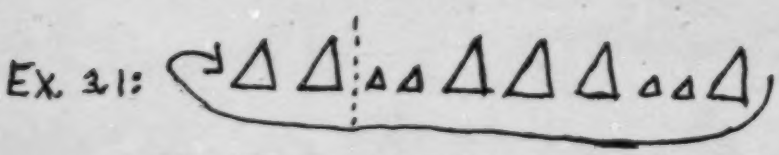
The purpose of the experiment was to see if individuals of differing ages and with varying musical backgrounds would choose one representation over another and to see if they could decode representations that were not congruent with their initial choice. In fact, individuals who did not read music (even those who played a little "by ear") always chose Type II drawings. Those who were performers who did read music, invariably chose Type III drawings. In addition, participants spontaneously rejected drawings of a type different from the one of their choice. They insisted that such drawings were wrong or else must be a different rhythm. Once again, then, we found the disjunction between figural and formal strategies and in these pure examples a resistance even to the possibility of shifting focus from one to the other. Instead, participants often spontaneously "fixed up" drawings they had labeled "wrong" so as to make them congruent with their own strategies. They could not initially shift their focus to

make it congruent with the strategy represented in a drawing that was non-congruent with their own.

Only later, and often with considerable difficulty, some, but not all participants were able to integrate the strategies sufficiently to see that each type captured different but valid features of the figure. I will return to the significance of this point at the end of this section.

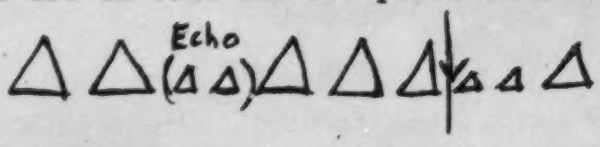
Most revealing are the instances where individuals fixed up the drawings to make them fit their own strategy. In these situations, participants doggedly maintained their inital figural or formal mode of representation, imposing it often with considerable imagination on a drawing of another type.

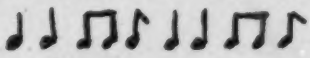
For instance, one adult who had played the rhythm from Example 2.1, said, "How can Example 3.1 be the same rhythm as Example 2.1? He then suggested that: "Example 3.1 starts in the wrong place. If you begin with the two small triangles, then you can wrap it around".



In this way he neatly imposed Type II strategy on a Type III drawing. That is, he found in Example 3.1, contiguous, like shapes which matched his way of grouping the figure into motivic chunks. He had only to read smaller shapes as slow and larger shapes as fast.

Another Type II player said of Example 3.1, "The two little triangles are an echo and the piece ends here:

Ex. 3.1: 

A Type III performer on the other hand, suggested that Example 2.1 was "hard to play". "The 5th clap is wrong because you have to wait longer there; it's hard to play it with a short clap there." His performance was: 
He thus decoded and performed the Type II drawing as if it were a Type III encoding. He assumed that, like a Type III drawing, larger shapes stood for larger durations and smaller shapes for shorter, and he then actually played the drawing quite literally in those terms. His strategy, in turn, led him to conclude that the drawing did not properly represent the rhythm, it was wrong not his decoding. In contrast to Type II players, this Type III player made no attempt to fix up the wrong drawing; he simply performed the set of durations in terms of his mode of representation.

From these examples it seems quite clear that performance, indeed understanding, of a drawing is in terms of the decoder's representational strategy. If the encoding strategy is non-congruent with his own, the decoder concludes that the encoded message is wrong, is incomprehensible, or he reinterprets the

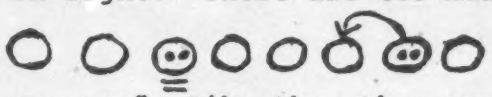
representation to make it congruent with his own. Even though the participants had been told that all the drawings represented the same rhythm, none engaged the possibility that his own representational strategy might be different from that of the encoder or made an effort to discover what the difference might be.

The next phase of the experiment focused on just this issue. The various representational strategies were explained to each participant. The features captured by drawings that were not congruent with the one of the participant's choice were carefully described. We were especially interested to see if participants could bridge the gap between Type II and III. In each case the participant visibly resisted giving up his own mode of representation--i.e., restructuring his way of thinking the figure and thus shifting his focus to different features. Most interesting, when restructuring from Type II to Type III did occur, the participant turned against his previously favored drawing. For example, a participant who had originally played from Example 2.1 on grasping the features captured by Example 3.1, said, "Then Example 2.1 is wrong." Another player managed to make the shift quite explicit: The woman who was initially a Type II performer and who described Example 3.1 as showing "an echo", drew Example 3.1 underneath Example 2.1 and said, "They are the time in between." Her focus shifted from motivic grouping to measuring durations.

2.1

3.1

To trace the whole process, the following is the history of one college student's behavior during the experiment. He began by playing from Example 2.1. When asked how he knew how to do it, he said, "Well, you can see that the three little ones go together." He then identified Examples 2.2-2.4 as similar to 2.1 and typically rejected the others as wrong. When shown how to decode Example 3.1, he looked confused and said, "I really have to rearrange my head." Curious, then, about Example 4.1 he conjectured that, "The three little ones (in Example 2.1) are the two dots AND the circle but it doesn't go on right. There are too many circles and the dots



are in the wrong one." Like the other participants, he found a way of decoding the drawing so it was congruent with his original Type II decoding strategy--i.e., captured motivic grouping. He then simply rejected what he couldn't fix as wrong.

Finally, it was only the adults, and not all of them, who were able to grasp that each drawing when taken separately, captures a particular feature, a particular dimension of the structure while in their collective capacity they create a multi-dimensional description of the structure. To grasp this collective aspect of the drawings, an individual must be willing and able to shift his representational strategy. Moving through the drawings, the experience is one of flipping from one set of features to another, each time focusing on and apprehending new features and, indeed, a different structure.

But to acquire the ability to flip features requires, first of all, a willingness to accept the possibility that there are other features than those which you initially grasp--to entertain the notion that there is more than one window to this little world. The willingness there, you must also have access to those features which are not included in your spontaneous representation. This was not possible for all participants. The young children had difficulty with metric representations and, as I shall show, this was a question of the development of fundamental cognitive tools. The professional musicians, for quite other reasons, had trouble accepting figural encoding. Naive Type II adults proved the most willing and able to shift strategies but even they tended to hold fast to "the right answer" as they turned against their initial Type II decoding.

Thsoe who could grasp the richness of description in the collective set saw that none of the drawings was a complete description of the figure, that only together they captured the varied facets of its structure. These participants either had or were now on the way towards a higher level strategy that could integrate both figural and formal features.

In Part III I have shown various ways in which figural and metric strategies can interact. The hybrid examples, illustrated how a particular mix of strategies and the priorities given each can influence the way an individual <u>thinks</u> the figure--e.g. metric focus can influence the way the performer moves through a

felt path.

In the encoding-decoding experiment I showed how an individual's decoding of a particular message will depend on his own encoding strategy. If there was incongruence between encoding and decoding, the participant rejected the encoding as incomprehensible, fixed it up to match his own representation or concluded that it was simply describing a different rhythm. None of the participants initially considered the possibility that the feature focus of a particular encoding might be different from his own. The opportunity to shift focus was met with discomfort; only a few participants were both able and willing to flip from one strategy to another. Finally, I suggested that with the ability to integrate strategies the individual can gain the power to manipulate the figure in his imagination, to chose one interpretation over another, or later, even to transform the figure into a new, but still related one as he isolates features keeping some the same but changing others.

In the next section I will discuss the implications of this ability to isolate features, to integrate them in new ways and thus to arrive at a new reconstruction of the "same" phenomena. Particularly, I will show the implications of this higher level strategy for the performance and understanding of music and also some implications for teaching and learning in other domains as well.

Part IV.1

Implications for teaching and learning

Before plunging into this discussion, I would like to summarize as clearly as possible the distinctions between the two strategies. Figural strategy is based on sensory-motor response, on a felt path generated by bodily movement. As it develops over time, this felt path becomes more highly articulated, its representation captures more distinctions and more landmarks--it becomes more specific, more refined. But, still, figural strategy maintains a focus on contextual functions which result from the ordering of events and their durations within a particular figure. Metric strategy is based on the classification of events according to durational invariances. It provides a scheme for naming events regardless of contextual function and regardless of the position of the event in a particular figure. Thus, events with differing functions (beginning, ending) will be the same if they share the property, same position in the metric grid. Metric strategy provides, then, a single time through which to describe the varied times of the whole.

I have tried to demonstrate that individuals tend to operate in one mode or the other even rejecting as irrelevant or wrong, features captured by a strategy other than their own. At the same time I have stressed that both kinds of features are valid aspects of the structure and hinted that both are necessary for productive learning and for intelligent musical performance and understanding.

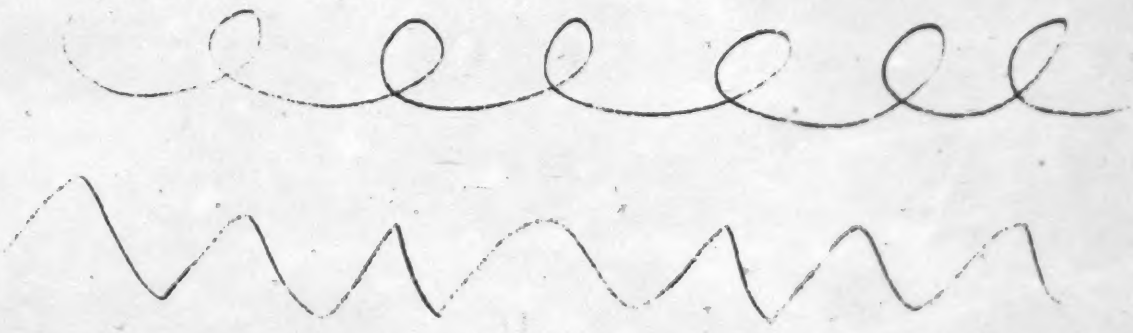
The trick, then, is to use one strategy to enrich the other; metric or formal strategy provides access to abstractable features, to the separation of elements, and therefore to new means with which to build relations or to understand those which may be at first incomprehensible. Formal learning thus leads to the "surfacing" of features which may have been hidden in their immediately perceived, fused relations. This kind of looking at the phenomena, rather than directly responding to its effect leads, then, to awareness of new features. These new features can

later become integrated into immediate apprehension--direct, figural experience is enriched, made more complete, perhaps even restructured. In this way, too, affective response can be transformed. What was at one time a boring piece can later become a dramatic piece simply because the features crucial to the drama are now accessible, a functioning part of the context.

Turning now to the possibilities for intervention, we considered all the data I have described thus far, and tried to design a teaching-learning situation that would lead children towards the ability to flip focus and eventually to an integration of the two strategies. Our own strategy was initially set off by certain specific aspects of the data. The clear disjunction between figural and metric strategies seemed associated with age and development. The two extremes of the strategies we found only among the two extremes in our age group. That is, Type I drawings were found only among the very youngest children--6 - 7 year olds; Type IV drawings were found only among the oldest children--11 - 12 year olds. Then, in the decoding experiment it was clear that the younger children would not accept metric representations as valid nor could they decode Type IV drawings at all. In contrast, the older children and the adults seemed only to need another vehicle of description in order to shift their focus from figural to metric features. Given another notation, the adults could (if somewhat reluctantly) direct

their attention to these other features of the figure. Thus, they were quite capable of thinking in terms of an invariant unit, a single time that would apply to all events and in relation to which varied durations could be consistently described. The adults clearly "had" the concept; it was easy, by analogy with its operation in other domains, to apply it to this set of phenomena. For the younger children it was another story. Put in the context of general cognitive development, it seemed clear that indeed, a cognitive leap was necessary to bridge the gap between figural and metric representations. Centered in their own actions, their felt path of performed events, the younger children could not distance themselves from, reflect on, this sensorimotor mode sufficiently to capture an underlying invariant unit which, though generated by the performed events, is not actually present in them.

A more extreme version of behavior tied to action may make the developmental issues more clear. We found among the drawings of the youngest children (roughly 4-6 years old) pictures which were simply a series of squiggles or jagged lines, they showed neither the correct number of events nor any indication of grouping:



These children simply played-drew some motions on the paper. In contrast to Type I drawings, the trace left shows only a series of undifferentiated events. Even the graphic use of a spatial gap to capture the larger motivic chunking of the two repeated motives, as in Type I drawings, is entirely missing in these drawings. We see only diffuse movements across the page--time marked off by an undifferentiated flow of events.

In comparison to these earlier drawings, Type II strategy can be seen as a highly developed and consistent mode of representation. But, still, as long as a child remains centered in his own actions, first tracing them on the paper and later articulating them into figural chunks, his focus remains on the relations among immediately contiguous events; it is dependent on the fixed ordering of events rather than on relations to a fixed reference. Piaget gives the term "perceptual" or "intuitive" to this earlier stage of development and describes what I have called figural groups as "perceptual structures" or "perceptual sets."

The construction of "perceptual structures" involves:

> Acts which consist solely in coordinating successive perceptions and (also successive) overt movements (which) can themselves only be reduced to a succession of states, linked by brief anticipations and reconstructions, but never arriving at an all embracing representation; the latter can only be established if thought makes these states simultaneous, and thus releases them from temporal sequence characteristic of action.[8]

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[8]Piaget, J., The Psychology of Intelligence, p. 120.

But there is an important difference in the tasks involved: Piaget is describing, here, the behavior of pre-operational children when confronted with the task of sorting objects that "go together" by invariant property (color, shape). Given an array of shapes of varying colors, a strategy influenced by the child's particular "temporal sequence characteristic of action" is, of course, inappropriate to the task. Typically it results in the child stringing together shapes in a long chain, shifting from one property to the other or even building "a train" or "a house" as he moves through the array of objects in a kind of "felt path". But when the task is one of reconstructing the "good perceptual forms" of rhythmic figures, a strategy which focuses on "situational properties" on "temporal sequence", on "successive perceptions and successive overt movements" seems entirely relevant. Thus, we might have expected to find the reconstructions characteristic of Type II strategy coinciding developmentally with the construction of those "perceptual structures" which pre-operational children make when confronted with the classification task. But remarkably the fully developed figural strategy reflected in Type II drawings occurs only when children are well into concrete operations. Only then do they capture the relations which articulate the structure into motivic or rhythmic groups. And this is so even though these groups are generated by the particular <u>arrangement</u> of durations, by events that "go together" as a result of their "situation"--

i.e., as a result of the particular contextual embedding in which they occur.

A parallel that comes to mind is the extremely close developmental link between seriation and classification. In the seriation task the child starts off with a highly acceptable "good perceptual form" which he is asked to reconstruct. Classifications, in contrast, are not only independent of such perceptual forms but the child is even hindered by a tendency to be influenced into making good "perceptual sets". Thus, one might think that seriations would occur earlier than classifications. But in spite of their differences, strategies which deal successfully with both the seriation and classisification tasks are marked by similar developmental turning points at ages which are roughly the same.[9]

Type IV strategy is also the result of clear developmental growth--i.e., from the comparison of durations one to the other in Type III drawings to measuring exact duration in relation to an invariant unit time in Type IV drawings. Indeed, Type IV strategy seems to require the same kind of operative development that Piaget has observed in the child's construction of the notion of time as it functions in the much more complex compuattional relations between duration, speed and distance covered. A fully developed metric strategy similarly requires the child to distance himself from immediate experience, to remove events from the particular ordering in which they occur by making them simultaneous in imagination and by comparing them with an invariant grid. The development into metric strategy must wait until:

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[9]Piaget, J. and Inhelder, B., Early Growth of Logic, pp. 290-295.

> ...temporal relations are merged in the notion of a single time, or the point at which elements of a complex are conceived as constituting an unvarying whole or the inequalities characterizing a system of relations are serialized in a single scale...arriving at a system which is both complete in itself and indefinitely extensible.[10]

But interestingly this capacity may at the same time deprive the listener-performer's experience of the qualitative effect of these relations. Piaget, himself, emphasizes the necessity for coordinating the two modes of representation:

> We must establish a mobile unit that lends itself to repeated application (iteration) and to substitution for any other unit in the series [the invariant unit time]. For example, the unit, A, might be such that we can say B=2A or C=3A, etc. Now since that duration can be substituted for any other, it loses its distinctive quality. So as soon as it comes to distinguishing between any two A's (e.g., two different hours) we are forced to reintroduce their general succession in the form of the precise order in which the identical motion, X, was repeated.[11] [12] [13]

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[10] Piaget, Jean, The Psychology of Intelligence, Littlefield, Adams and Co., 1960, p. 139.

[11] Piaget, J., The Child's Conception of Time, Basic Books, Inc., 1969, p. 175.

[12] Or compare the distinction with this comment of Wittgenstein:

> Consider what makes it possible in the case of physical objects to speak of two exactly the same, for example, to say "This chair is not the one you saw here yesterday, but is exactly the same as it." Wittgenstein, Ludwig, Philosophical Investigations, The Macmillan Co., 1953, p.

The whole question of repetition, of the "again" phenomena needs further investigation. I will turn to this issue in the subsequent papers.

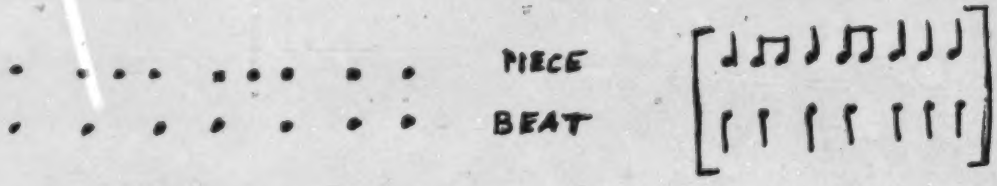
[13] I am grateful to Hermina Sinclair de- Zwart for her careful reading of the manuscript and particularly for her very helpful suggestions in this section concerning the relations of the data to development and to the work of Piaget.

So while Type II strategy seems to focus on something like "perceptual structures" and Type IV strategy on measuring and classification, both occur through a process of growth and development and both are necessary to a full representation of rhythmic structures.

In designing our teaching strategy, then, we needed to consider two fundamental aspects of our data: 1) both strategies provide powerful tools necessary for representing even simple rhythms; and 2) the cognitive capacities necessary for metric strategy are probably inaccessible to the youngest children. We thus focused our attention on what seemed to be "transitional children"--for example, those who had made hybrid drawings. But in trying to show them how metric strategy worked, we were determined to give the children the power of these formal analytic tools without depriving them of the equally important capacity they were so adept at, namely, their responsiveness to context, to function and to the qualitative sense of gesture and movement through time-

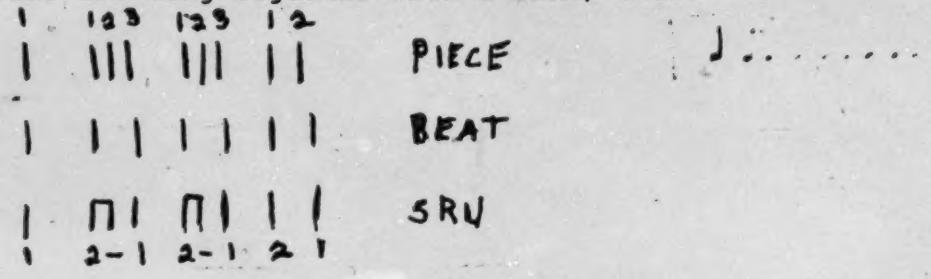
space. The difference is almost one of becoming and being--of change (gets faster) in contrast to static definition (twice as fast).

Since the spatial analogue notation so powerfully captured both kinds of features, we chose it as the best vehicle of description. To bridge the gap between action and reflection on it, we presented the representation, first, in an action mode. Working in pairs, one child pulled a piece of paper slowly across the table while the other played a rhythm by moving his/her crayon up and down "in place" over the moving paper. Going back to the beginning of the trace left, the drawer then played a steady beat in the same way. If drawer and puller managed to maintain the same pace, the same tempo, the result was a two dimensional drawing:



Thus, through their actions they could capture the features of both figural and metric structure. The initial "performance" captured figural groups defined by the larger space-of-time between events. The second pass supplied the invariant unit. Looking at the result of the two performances, the children could see directly

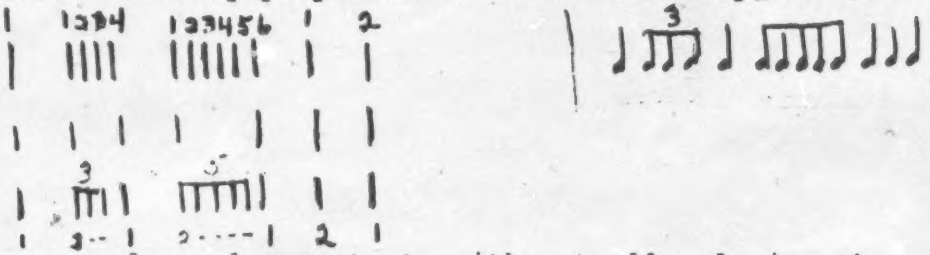
the coordination of beat and piece. With this coordinated picture before them, now in a static representation, the translation from a spatial analogue to a metric representation was quite simple. The strategy was as follows: all events that equal the unit beat stand alone. Events that together equal the space-time of the unit beat are hung together with a beam, thus:



Indeed, the translation led them to standard rhythm notation (SRN) which is simply a particular way of encoding metric features.

In this way the child actually sees the transformation from a figural drawing into a metric representation take place before his very eyes. His movements first generate a visable figural grouping along with a picture of longer and shorter durations. The second pass coordinates the beat with the piece. Putting on the beams, shows the exact duration of each event. At the end of the process the figural groups of 3 (|||) are transformed into measured groups of 2+1 (⊓|). He has parallel descriptions of the "same" material--one the <u>means</u> the other the <u>effect</u>. Thus, the process allows the child to move back and forth from figural to metric to figural representation--he is practicing the integration of the two strategies. In addition, the process is extendible to more complex figures; it is generalizable to any set of durations because it is based on an underlying principle--the invariant grid, the beat, as a unit of measure. For example, such figures as this

were just as notatable as the simpler ones which included only two kinds of durations and only proportional relations among them:



But still, the procedure always starts with actually playing the figure on the paper and ends with a metric representation that can reveal the features hidden in, but responsible for, the initial figural representation.

But for the younger children it didn't work. They could make the two-dimensional picture as long as they were actually doing it--i.e., with paper-puller and crayon-player. But, when they tried to reconstruct the relations without actually playing it on the paper, they failed. The initial spatial analogue they could make--since it is, after all, still a playing-drawing activity. But they could not coordinate the beat with their initial drawing in their imagination--i.e., show where the beat coincided with the piece without actually doing it. The reason, as discussed earlier, seemed embedded in their general cognitive development.

As a result we concluded that these younger children should be encouraged to elaborate on and to enrich their figural representation. They should be given the opportunity to make further articulations, to discriminate among figural features, and to invent other designs. We should not try to impose on them the metric strategies

of standard notation. While they could certainly learn to read SRN, they would at this stage of development be limited to decoding it as a set of icons. That is, they could learn that a certain picture of durations sounds a certain way. The nemonics often used in schools (ta ta ti ti ta) are another means for encouraging this kind of iconic encoding-decoding. But to us it seemed more important for the children to extend their figural strategies, to develop them so that later on they could make use of these highly developed skills, integrating them with metric representations when these were easily accessible.

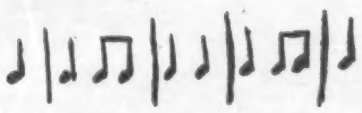
We were further convinced not to impose SRN on the younger children by watching the problems they encountered when trying to decode it. SRN rests on the same strategy as Type IV drawings but it is a more complete,a more inclusive code. Because it provides, in its code, a ruler, a single fixed reference, with which the decoder can describe the duration of any event in a figure or a whole piece, it is perfectly effective in telling the performer just how long to play each note. It is, thus, a practical and necessary set of instructions for performance within the single dimension which it captures. However, its graphics, like metric drawings, obscure figural relations and thus confuse figural decoders.

In its simplest form, as we have seen, SRN graphically encodes the relation of particular durations to a unit time by hanging together with a beam all durations less than the unit which together equal the unit duration. For example:

A graphic group then stands for an

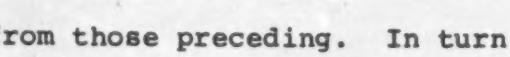
aggregation of contiguous events which together equal the unit time.

But, because SRN tends to obscure figural grouping and because it also does not explicitly expose the relation of beat to piece, (as Type IV drawings do) SRN tends to create specific problems for the figural decoder. Namely, the figural focus of the performer leads him/her to read the graphically aggregated metric units as standing for motivic aggregates or motivic chunks. For instance, consider the following notation for the example in Part I:

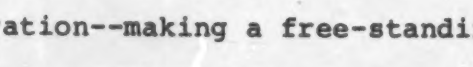


The graphics of SRN aggregates events according to the hierarchic metric structure of the figure: Beams ( ) indicate an aggregation of events in relation to the unit time; bar lines (| |) indicate the next higher (or larger) metric unit, the aggregation of unit beats again into twos making a 2:1 ratio throughout this temporal hierarchy. Figural decoders, however, see these signs not as metric units but as marking figural chunks. The they read as "getting faster" but also as "going together", a contained gesture. Now in order to make this pair go together as a figural group, the figural decoder makes a pause, a gap before and after it to separate the supposed chunk from the events on either side. Thus the figural decoder systematically imposes on the SRN "drawing" those features which, in his strategy, generate

figural chunks. That is, a figural chunk is most typically set off by a change of pace which "gets faster", separating these faster events from those preceding. In turn, the figural group is bounded at the end by another change of pace, an event again of longer duration--making a free-standing chunk. The figural decoder, seeing what looks like a chunk, simply makes one. The performance which results is something like:



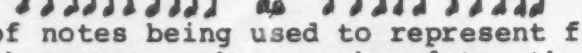
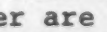
The metric notation when decoded as pictures of figural groups doubly interrupts the actual figural grouping which we saw displayed in Type II drawings:



The first inner figural group is interrupted by the bar line, the second by the beamed events and the bar line. In turn articulation of the two repeated figures is not captured at all in SRN; there is no graphic separation between the two repeated segments, no indication of this chunking which even Type I drawers captured.[14]

So we see, here, another illustration of incongruence between metric encoding and figural decoding. Indeed, it is quite similar to the behavior we observed in the experiment described in Part III.2. That is, figural decoders impose on a metric encoding a strategy which matches their own strategy of encoding.

And as in our experiment, explanation of metric encoding (in this latter case, SRN) is not grasped by the youngest children because

[14] Among adults we found a kind of reverse incongruence: college students who said they could read music, wrote the rhythm,  Here we see pictures of notes being used to represent figural grouping--i.e., the events that go together are bound together graphically (as in ). However, an SRN decoding of this "drawing" would understand the three beamed events as a group equal in duration to the unit time--a quite different figure from the original.

they cannot deal with its principle, namely, that there is an invariant unit time used as a fixed reference with which to measure the varied durations regardless of their contextual functions. As I have pointed out, young children can be taught to read given patterns of SRN as icons, a kind of picture vocabulary of rhythms. But then they will be limited to the pictures they have thus learned by rote. The habit of rote decoding may also make it more difficult later on to grasp the principle of SRN so as to extend it to any set of durations and to the hierarchical aspects of metric structure. And most important, an early emphasis on SRN may even inhibit the use and development of the child's natural figural strategies.

I would suggest then, that it would be more productive in the early grades to concentrate on modes of instruction which will encourage children to develop and refine their natural figural skills. If listening, playing and invention are combined with visually reconstructing what is heard and played, the child may naturally move, for example, from the random squiggles characteristic of the youngest children, through Type I drawings to Type II drawings. Then, later on, children can easily and productively add metric representations to their well developed figural representations. At this point they can be comfortably encouraged to flip feature focus, to freely restructure their descriptions and through this kind of practice to enrich their understanding and response.

Finally, this capacity to integrate possible strategies of structuring and representation constitutes, as Piaget and others have shown, an important step in the child's general cognitive development.[15] Indeed, the study of just how children, themselves, become aware of their own modes of representation, their own "windows to the world" and just how these may shift and become integrated, can provide crucial insights into the processes of learning. Despite the many different forms that these shifts and interactions can take in various domains, they could well all have something in common. Thus, as I shall suggest in the next section, such distinctions as those reflected in our data could help to make our grasp of these common mechansims more sure than it is at present.

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[15]See especially: Inhelder, B.; Sinclair-de Zwart, H.; Bovet, M.; Learning and the Development of Cognition, Harvard University Press, 1974, Chapters 6 and Conclusions.

Section IV.1
Some Speculative Implications

In the previous section I showed how developmental theory could suggest important criteria for when to introduce what kinds of interventions. At the same time I have tried to emphasize that while younger children are limited to figural modes of representation, figural strategy is not limited to younger children; indeed, figural strategy provides powerful tools for processing the world even into adult life. I would like to suggest now that traditional schooling tends to encourage the separation of the two modes (almost into public and private worlds) instead of encouraging strategies in which one can be used to enrich the other.

A typical instance of this separation into two worlds is encountered in first learning to play a musical instrument. Instruction traditionally begins with learning how to read standard music notation. The emphasis during this time is quite reasonably on counting, playing the right notes "in time", keeping the beat. As a result students typically play rigidly, at first, doggedly decoding in terms of the metric grid--every beat is marked, every downbeat is doubly marked. But soon the student is admonished to play "more musically" to "phrase", or even to "play with feeling". This means, (in our terminology) to find (or re-find) a figural grouping which is often obscured by the singular focus of SRN.

But strategies for getting from SRN to "phrasing" (i.e., from metric to figural representation), for using one to enrich the other are rarely made explicit. The student is left to "intuit" such strategies by himself. Through imitation, (s)he must somehow put together a series of particular instances or particular local instructions in which the strategy may be embedded hopefully arrving at the ability to integrate the notation with "phrasing" in new situations, without the teacher's model.[16] But sadly, if the student is not successful, he is often dubbed "unmusical" or even "untalented". While the student who can more quickly "intuit" effective means for getting from the score to "playing musically" may, indeed, be more "talented", the others need not be left to ignominious defeat. Talented as well as "less talented" students can both develop their abilities if they are helped to understand ways in which each strategy can be used to inform the other.

For example, the student can be encouraged to ask such questions as: How do particular notated properties--pitch and duration--and their relations help to generate gestural groupings? What are the possible motivic groupings which a particular set of notes can create? Or, what features of the musical structure does your felt path (literally, the feel of the passage in your fingers) give priority to? What if you shift feature focus from the felt path to features that are not immediately accessible to your fingers--

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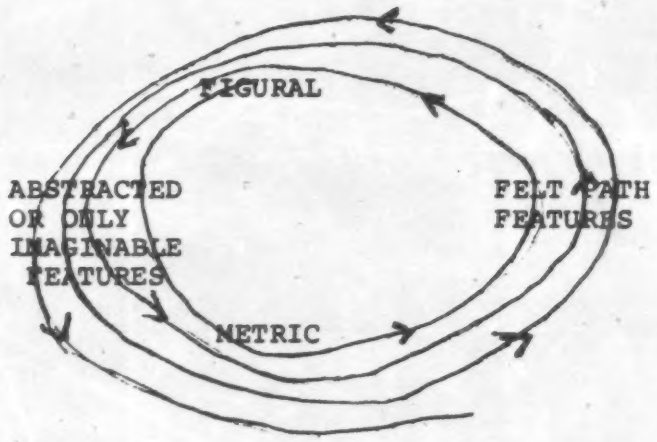
[16] This is, in the broadest sense, learning to read.

e.g., from a locally repeated rhythmic pattern to the harmonic rhythm? What if you experiment with felt path groupings (as in Example 2.1a vs. H.1); what hidden features of the structure will surface? Or, conversely, what if you look <u>at</u> the means, taking apart features fused in immediate experience; what features will you discover that might influence your felt path--or even the effect you want to project (as in Example H.2)? Such questioning <u>in practice</u> stimulates students to spiral through both figural and formal modes of thinking a passage or a whole piece, each loop enriching the representation of the one before.



A more general effect of the tendency to separate the two worlds can be seen in ordinary classroom situations. The results particularly of the encoding-decoding experiment illustrate in a limited but very telling way a pervasive but often hidden issue

that often underlies problematic teaching-learning situations. It is precisely the problem of incongruence between the strategy of representation implicit in a teacher's encoded message and the strategy of representation in the child's decoding of that message. As the experiment shows, there is considerable reluctance involved in shifting strategies. Even when the features captured by each strategy are made explicit, it is often deeply disconcerting to be confronted with a different window to the world. But much more serious is the situation where the incongruence remains hidden often from both teacher and child.

The teacher, unaware of the tacit assumptions inherent in a particular formal description of some phenomena, may find the child simply "unable to learn". The child, using a figural strategy, may find the adult's description "incomprehensible, wrong or he reinterprets it to make it congruent with his own." But because the teacher's encoding contains the "right answer" the child (unlike our participants) repeats it like a ritual incantation without ever explicitly noting the incongruence and certainly without reconciling the disparate modes of representation. The "right answer" thus becomes a kind of magic trick which has little to do with the child's figural, context-dependent "reality", with "same and different" or even with "truth". And in the process he hides his "wrong answer" (often with a feeling of shame) while he is in school, defensively saving his own figural modes of representation for use outside of school where

they may work perfectly well. Or the child may simply be labeled a "poor learner", assigned to remedial work which, by repeating the formal incantations, may even reinforce the incongruence rather than resolving it.

Our experiments would suggest that a solution might lie first of all in giving both teacher and student strategies for confronting such incongruence and specifically strategies for looking at, for making explicit the features and relations captured by various possible modes of representation. This means at least encouraging teacher and child to develop multiple descriptions, inventing, like our participants did, representations that reveal features that are salient but may be hidden by any single strategy. This, in turn, can spring the trap of the "right answer syndrome". In this way the child can be encouraged to trust his own intuitive strategies, to search for good descriptions of the features they capture and even, through them, to crack the formal code. In addition such multiple views encourage both teacher and child to develop the ability to flip focus, an ability which may lead both of them to new knowledge and to a better understanding of one another.

Finally, I would like to suggest that the tendency to teach and learn in one mode or the other derives from the tendency to associate each with a particular domain of learning or teaching. Figural learning tends to be private, personal, captured in imagry and, like the children's drawings, associated with felt

paths, direct sensory experience. As such, this kind of knowing is hard to communicate, hard to teach, in fact is often deemed unteachable, intuitive, something arbitrary, capricious, subjective.[17] Formal learning is more public, more easily communicated since it is captured in naming, in symbols which represent often, invariant properties, the logic of class membership. Formal learning reveals features which cannot be experienced directly. It requires a distancing from direct experience since it gives names to features which, as separate entities, can only be imagined--like pitch and time which one can experience only in fusion, never separately and never without an object to generate them.

But both kinds of strategies can be highly developed. The eskimo or the Indian on the planes travels his terrain by felt paths learned through direct sensory experience. His felt path is highly structured, rich in details, landmarks which guide him as he moves through this felt path from one to the next. In contrast, the ship's captain or the airplane pilot traveling in a fog, must navigate without landmarks, without a felt path map. His instruments show him measurements, coordinates, angles, degrees and clock time which must be invariant and not influenced by his

[17] Indeed, I suspect that this is the reason why musicians were so reluctant to accept Type II drawings in the decoding experiment. Figural representation is so closely associated with direct private experience--the feel of a passage in the fingers, the feel of the instrument to the lips, the feel of the bow in the arm, literally a felt path through a passage--that a "public" representation of it, a supposed notation, is simply unimaginable. A notation, a description cannot capture the features which seemingly must remain in a felt form; when confronted with an attempt, it remains unrecognizable.

felt impression of time, distance or motion if he is to reach his goal. Both kinds of learning demand the development of cognitive tools, but each captures features which are noticeably disparate--i.e., a felt path description captures features different from a coordinate map description of the same terrain.

I would like to argue, now, that the emphasis in traditional schooling is primarily on formal descriptions. It focuses on the features of the world that can be described in terms of the naming of invariances as captured in measuring and in symbol systems. Its goal is to develop cognitive tools associated with this kind of learning. Figural strategies, if they enter the classroom at all, are relegated to the "unstructured" part of the day--to play, to "imaginatively expressing yourself" and to the arts. But little attempt is made to reflect on the strategies which underlie these activities, indeed on the functional and contextual invariances (What generates an ending? What generates a group?) which are equally implicit in these modes of learning and knowing. It is my argument that figural knowledge is a powerful knowledge demanding the development of cognitive skills as specific as those of formal knowledge. But to be fully developed, figural knowledge needs to be informed and enriched through integration with the analytic tools of formal learning. In turn, the child in his more

natural habitat--on the street, on the playing field, develops and makes use of figural strategies that could be extended into the realm of formal knowledge. But because figural strategies and the knowledge they require rarely enter the classroom, the child is kept from using his highly developed skills either as a path into formal strategies or as a knowledge to be informed by them. And yet, I would argue that creative learning, new knowledge and insight in social, artistic and scientific domains depends on the dynamic interaction between the two modes of learning. It is precisely the interactions between particular, context-dependent immediately observed experience and the ability to take it apart, to reflect on it, to explicitly capture its features in measuring, naming and in this way to shift the sense of same and different, to restructure features and relations that leads to invention and discovery. By keeping the two worlds separate we inhibit our own discoveries as well as the children's; we put a lid on the potential of both worlds when we contain them each within their separate domains.